FIELD INVESTIGATIONS OF UNCONTROLLED HAZARDOUS WASTE SITES

FIT PROJECT

TASK REPORT TO THE ENVIRONMENTAL PROTECTION AGENCY CONTRACT NO. 68-01-6056

Cost Estimate For Clean-Up Of Contaminated Groundwater And Soil At The Reilly Tar And Chemical Company Facility

St. Louis Park, Minnesota

ecology and environment, inc.

International Specialists in the Environmental Sciences

TABLE OF CONTENTS

INTRODUCTION

A cost analysis outline has been formulated by FIT in an effort to produce a reasonable estimate for the cost of clean-up of contaminated groundwater and soil at the former Reilly Tar & Chemical Company facility in St. Louis Park, Minnesota. The cost estimate is based upon numerous assumptions and will be limited to the following six areas:

1. Treatment of water from all St. Louis Park Municipal wells.
2. Remedial activity regarding approximately fifteen (15) "multi-aquifer" wells.
3. Contaminated soil removal, disposal, and replacement.
4. Remedial activity (clean-up) regarding on-site Well #23.
5. Barrier well field construction, monitoring, and treatment of pumped liquid(s).
6. Well field management (monitoring).

Cost estimates for the above areas will include options whenever possible.

The cost analysis is based upon numerous assumptions which are depicted in the narrative for each element of the cost estimate. Assumption modifications will alter the cost of an element and hence change the final cost estimate. The "worst case" cost is assumed whenever a range of costs are available. Representative figures are used in several portions of this analysis due to a lack of accurate estimates for some elements. Contingency costs of 10% are included in the total cost of an element unless otherwise noted.

I Treatment of St. Louis Park Well Water

Detectable concentrations of phenolics and some Polynuclear Aromatic Hydrocarbons (PAHs) in the St. Louis Park municipal well water justifies considering the construction of a pretreatment plant or modification of the existing water treatment facility. Cost estimates for three options were determined as follows:

1. Pretreatment with regeneration,
2. Pretreatment without regeneration, and
3. Modification of existing facility.

Assumptions for the above options include:

1. A design flow of 1500 gpm.
2. An existing piping system that could direct flow to and from a pretreatment facility.
3. The use of granulated activated carbon for carbon absorption.
4. Granular activated carbon dosages of nine (9) to twelve (12) ppm being effective in the treatment of "contaminated" well water.
5. A life of thirty-five (35) years for the facility.

The steps of treatment to be added to the existing water treatment facility for activated carbon adsorption with regeneration include:

1. Absorber columns yielding clean water to sand filters in existing water filtration plant,
2. Spent carbon to furnace, and
3. Reentering reactivated carbon into columns, plus adding new activated carbon to replace activated carbon lost through this process.

The steps of treatment to be added to the existing water treatment facility for activated carbon absorption without regeneration include:

1. Absorber columns yielding clean water to sand filters in existing water filtration plant, and
2. Spent carbon sent to reactivation center.

The steps of treatment for modifying the existing filtration system include:

1. Replacing eighteen (18) inches of existing sand filtration media with granulated activated carbon,
2. Removal and disposal of existing media, and
3. Periodic replacement of activated carbon being mechanically implemented by carbon suppliers using vacuum trucks.

1. Pretreatment with regeneration
A. Capital Costs

Activated carbon absorption with regeneration - New system component installed construction costs:

Subtotal	$ 1,100,000	
		$ 1,100,000
Piping (10%)	$ 110,000	
Electrical (8%)	$ 88,000	
Instrumentation (5%)	$ 55,000	
Site Preparation (5%)	$ 55,000	
Subtotal	$ 308,000	
		$ 1,408,000
Engineering & Construction Supervision (15%)	$ 212,000	
Contingencies (10%)	$ 141,000	
Total Capital Costs		$ 1,761,000

B. Operation and Maintenance (O & M) Costs

Labor	$ 120,000	
Materials	$ 41,000	
Chemicals	$ 8,000	
Energy	$ 62,000	
Subtotal	$ 231,000	
Total O & M Costs Per Year		$ 231,000
Life of 35 Years		x 35
Total O & M costs		$ 8,085,000

The total costs for the life of the above system is $9,846,000.

003238

2. Pretreatment without regeneration

A. Capital Costs

Activated carbon absorption without regeneration - New system component installed construction costs:

Subtotal	$ 570,000	
		$ 570,000
Piping (10%)	$ 57,000	
Electrical (8%)	$ 46,000	
Instrumentation	$ 28,500	
Site Preparation (5%)	$ 28,500	
Subtotal	$ 160,000	
		$ 730,000
Engineering & Construction Supervision (15%)	$ 110,000	
Contingencies (10%)	$ 73,000	
Total Capital Costs		$ 913,000

B. O & M Costs

Labor	$ 120,000	
Materials	$ 41,000	
Chemicals	$ 90,000	
Energy	$ 14,000	
Subtotal	$ 265,000	
Total O & M Costs Per Year		$ 265,000
Life of 35 Years		x 35
Total O & M Costs		$ 9,275,000

The total costs for the life of the above system is $10,188,000.

003239

3. Modification of existing facility
A. Capital Costs

Activated carbon absorption without regeneration - Modifying existing water treatment plant.

Subtotal	$ 600,000	
		$ 600,000
Engineering & Construction Supervision (10%)	$ 60,000	
Contingencies (10%)	$ 60,000	
Total Capital Costs		$ 720,000

B. O & M Costs

Total O & M Costs Per Year	$ 90,000
Life of 35 Years	x 35
Total O & M Costs	$ 3,150,000

The total costs for the life of the above system is $3,870,000.

II Multiaquifer Wells

An unspecified number of existing uncased and/or ungrouted wells which penetrate more than one (1) aquifer in the St. Louis Park area may be contributing to the spread of contamination between aquifers. These multiaquifer wells are being identified and field located for possible reconstruction to monitoring wells or barrier well or possible abandonment. For this element of the cost analysis, the number of multiaquifer requiring attention is assumed to be fifteen (15).

A. Identification and location

Identification of multiaquifer wells is an ongoing project of the USGS and local agencies. Sources of information were wells on file with the USGS, MGS, St. Louis Park DPW, previous reports (Sunde, 1974; Barr, 1977), area residents, employees of local business, and drillers. Since this work has and is being conducted by governmental agencies, identification costs were not estimated.

Cost for field locating of wells is difficult to estimate due to the great variability in field conditions. A majority of the wells have or will require a short field visit to locate. However, a few wells will require much time and effort to locate. More difficult searches may include the excavation of old building floors, roadways, alleys, and fields. An hourly charge of thirty (30) dollars is assumed for a person to field locate a well. The time to locate a well is assumed to be two (2) hours. A total cost of sixty (60) dollars is estimated. For more difficult well searches, the initial cost of sixty (60) dollars will be used plus the additional expense for excavation searches. The amount of eighty-five (85) dollars per hour for a machine (bulldozer with back-hoe) and operator was assumed. Based upon an eight (8) hour work day and assuming a working week (five day) search, the cost would be $3,100. For the cost analysis, ten (10) wells were assumed to be "no problem" finds and five (5) were estimated as one (1) working week searches. The cost for the fifteen (15) wells is $16,100.

B. Sealing (abandonment)

The cost for sealing a multiaquifer well is dependent upon the diameter and depth of the well. Costs associated with the implacement of chemical grout include material and installation costs. Assuming material costs of sixty (60) dollars per cubic yard and installation costs of one hundred sixty (160) dollars per cubic yard, the cost for grouting a well can be estimated. Assuming, that an "average" well has a ten (10) inch diameter and is five hundred feet deep, the well would require approximately ten (10) cubic yards of grout to seal. Therefore, an "average" well would cost $2,200 to seal with chemical grout. The total cost for fifteen (15) wells is $33,000.

C. Conversion to monitoring wells

The cost of converting a multiaquifer well to a groundwater monitoring well is is dependent upon the multiaquifer well design and the aquifer that is to be monitored. The following assumptions were made for multiaquifer well construction:

1. The well has a ten (10) inch diameter and is five hundred (500) feet deep.

2. The well will be grouted to a depth of three hundred (300) feet.

3. The monitoring well casing and screen will be 2-inch I.D. stainless steel pipe.

4. The monitored areas annulus will be sand packed.

5. The remainder of the annulus will be grouted.

Well Screen	$ 175
Stainless Steel Pipe	$ 3,900
Grout (9.75 cubic yards)	$ 2,145
	$ 6,220
Cost Per Well	$ 6,220
Fifteen (15) Wells	x 15
Total Costs	$93,300

III Contaminated Soil

The soils adjacent to and downgradient of the subject facility have been shown to contain significant quantities of coal tar derivations, including phenols and Polynuclear Aromatic Hydrocarbons (PAH's). Concentrations of the coal tar derivatives are much greater in the soils of the property than in the soils of the north portion of the site. To illustrate, benzene extractable concentrations greater than 1,000 mg/kg are present at a depth of 50 feet south of the site, while concentrations below the surface of the north portion range between 100 mg/kg to 200 mg/kg (Barr Engineering Report, 1977). Due to the potential impact of high concentrations of coal tar derivatives in the glacial drift, removal of the soil will therefore be addressed as a means of eliminating a major "point" source of contamination at the site.

Removal of contaminated soil involves a three phase operation: excavation of affected soil, removal and disposal of contaminated soil and groundwater, and replacement of excavated material with "clean", i.e., non-contaminated soil. Three excavation alternatives will be addressed: removal of soil to ten, twenty, and thirty feet, respectively. These alternatives are based on data presented in the Barr Engineering "Soil and Groundwater Investigation" of June 1977, the use of which necessitates establishing the following assumptions:

1. The Removal Depth Contour maps (Figs. 28-33) in the Barr Report accurately depict the area of contamination at the site.

2. The maps are accurate as to concentration levels at respective depths for two parameters (phenols and benzene extractables).

3. Soil removal calculations ignore structures, roadways, utility lines, etc., located in the proposed excavation area.

4. The original contours of the aforementioned maps have been slightly altered to facilitate measurement of the proposed excavation area. The measured contours were a composite of the Barr maps for benzene extractable and phenolic concentrations.

5. Any filling or grading work that has altered the site surface elevation since the 1977 maps has not been taken into account in the calculation.

The approximate volume of earth to be excavated in order to remove ten feet of soil over the (composite) contaminated area has been calculated at 1.15 million cubic yards. This corresponds to approximately 71 surface areas excavated to a depth of one foot. The volume to be removed amounts to approximately 45% of the total volume of the subsurface reportedly contaminated by phenols and/or benzene extractables.

The second option, that of removing twenty feet of the (composite) contaminated area would involve excavation of an additional 700,000 cubic yards, for an estimated 1.85 million cubic yards. This volume would comprise about 75% of the total contaminated soil volume. The twenty foot option would also eliminate benzene extractable concentrations greater than 10,000 mg/kg and phenolic concentrations above 100 mg/kg.

Excavation of a full thirty feet of contaminated soil would add approximately 400,000 cubic yards to the above, for a total of about 2.25 million cubic yards. This option would remove approximately 90% of the total volume of contaminated soil and would eliminate virtually all benzene extractable from the site (a small area between Lake Street and Minnesota State Highway 7 would remain contaminated below thirty feet in depth). All phenolic concentrations greater than 10 mg/kg would also be eliminated, leaving only low level contamination through sixty feet in depth.

Note:

1. All calculations are based on the Barr "Removal Depth Contours" maps. These have been rechecked and measured for scale accuracy, but other information presented can not be verified without data.

2. Structures, roadways, utilities, etc. have been ignored in the proposed excavation area.

Excavation, removal and disposal of affected soil, regardless of volume removed, will account for the major portion of this section's cost. Additional assumptions are imperative in order to complete an accurate cost estimate. These assumptions are listed below:

1. Dewatering of the excavation will be necessary with the groundwater table at approximately ten feet in depth.

2. Contaminated water will be removed from the excavation and treated at the proposed on-site treatment facility.

3. Contaminated soil must be hauled to the Waste Management facility in Chicago, Illinois for disposal due to lack of acceptable facilities closer to the site. This assumption ignores the possibility of proposed State of Minnesota hazardous waste site(s) becoming operational during the term of the project.

The following equipment and manpower, with attendant cost of operation is proposed for the excavation, removal and disposal phases:

Equipment (operator included	# of Units	Cost
Crawler Mounted Backhoe; 2 cu.yd. bucket	2	$940/day/unit
Track Mounted Front-End Loader; 2 1/2 cu.yd. bucket	2	$590/day/unit
Bulldozer; 65 h.p.	2	$430/day/unit
Dump-Trailers; 20 cu.yd. capac. (limited to 12 cu.yd. by weight restriction	120	$850/trip
Equipment Mobilization	-	$750
Spotters (at site)	2	$480/wk./man

The above equipment costs are projected over: 1) Eight hour work day, five day week; 2) 850 mile round-trip hauling distance, two days per trip, per truck; 3) Approximately sixty truck loads/day @ 12.5 cu.yds.

Based on the above, calculations show that an average of 750 cubic yards per day can be removed and transported for a cost of $51,000. Projected, this comes to a rough total of $78.2 million to remove ten feet of contaminated soils over a period of approximately six years of work. Deeper excavation will yield correspondingly larger amounts; at twenty feet of soil removal the cost for excavation and removal comes to about $123 million; for thirty feet of removal the estimated cost reaches $153 million.

Added to above costs are: 1) disposal fees, and 2) dewatering costs. The former is estimated at approximately $150 per truckload. Assuming the removal pace shown above, this would add another $9000 per day for a total of $60,000 per day for excavation, removal and disposal of contaminated soil. Projected for the ten foot excavation, this runs to approximately $92 million.

Dewatering of the excavation will be necessary whenever the removal depth exceeds ten feet. To enable uninterrupted work, two 6 inch pumps will be installed at a cost of $335 per day per unit. These pumps will connect to the proposed treatment facility (See Section V). Projecting the previous job length calculations, an approximate figure of $1.9 million must be added to the cost of the twenty (20)-foot deep excavation. Cost for pump operation rise to approximately $2.3 million for the thirty (30)-foot option.

The final phase of soil contamination mitigation involves replacement of excavated material. The assumptions are:

1. Clean fill is available on a local basis (haul distance within five (5) miles).

2. Sand, silt, and/or clay is acceptable for replacement fill.

3. Compaction of replacement fill is required.

Assuming the above, replacement of soil for the three (3) options will cost approximately $10 million, $15 million, and $19 million, respectively. The length of time for soil replacement is extremely variable depending on the amount of equipment mobilized.

The three (3) excavation options are projected to cost approximately $104 million, $155 million, and $193 million, respectively. These costs are approximate and accurate only when used in conjunction with the listed assumptions. Variation from the stated assumptions will alter costs and in some cases significantly.

IV Well #23 Clean-Up

A. Removal of Coal Tar From Well #23

It is necessary to remove the coal tar from Well #23 as it is a "point" source of contaminants for the lower aquifers in the St. Louis Park area. For the purpose of this estimate the depth to coal tar will be 595 feet, the well diameter will be eight (8) inches, and the total depth of the well is 909 feet. The method of removal of coal tar will be to core or rotary drill through the coal tar which has been described as a semi-solid material.

The cost for removal of coal tar from Well #23 was estimated at two hundred (200) dollars per linear vertical foot. The cost for coal tar removal will be $62,800. The removal of coal tar is based upon treatment of the coal tar material at the proposed treatment facility (See Section 5C).

B. Sealing Well #23

After removing the coal tar from Well #23, it would be possible to seal the well with a chemical grout. Assuming that the well has an eight (8)-inch diameter, is 909 feet deep, and there is no significant leakage of grout into the surrounding rock, the amount of chemical grout needed to seal the well is approximately twelve (12) cubic yards. Based on the cost of sixty (60) dollars per cubic yard for materials and $160 per cubic yard for implacement of the grout, the cost for sealing the well is $2,640.

C. Recompleting Well #23 For Monitoring

Recompleting Well #23 into a monitoring well will be based upon the assumptions that only the Hinckley aquifer will be monitored. The conversion costs assumptions are as follows:

1. The monitored (screen) interval will be from a depth of approximately 900 to 910 feet.

2. The annulus around the screen will be sand packed.

3. The remainder of the annulus will be grouted.

4. The monitoring well casing and screen will be 2-inch I.D. stainless steel pipe.

Well Screen (10 feet)		$ 300
Stainless Steel Pipe (900 feet)		$ 13,500
Grout (12 cubic yards)		$ 2,640
	TOTAL COSTS	$ 16,440

D. Relief Well

The cost of construction and installation of a relief well to pump contaminants from the area of Well #23 are based upon the following assumptions:

1. The diameter of the well will be eight (8) inches.
2. The depth of the well will be 910 feet.
3. PVC casing will extend to a depth of 800 feet.
4. A six (6)-inch submersible pump will be adequate to pump the liquid.
5. The pumped liquid will be treated at the proposed treatment facility (See Section 5C).

Drilling-Auger Method (80 feet @ $20/foot)	$ 1,600
Coring Rock (830 feet @ $100/foot)	$ 83,000
Eight (8)-inch PVC Casing (800 feet @ $10.50/foot)	$ 8,400
Six (6)-inch submersible pump (200 to 500 feet deep and producing 15 to 135 GPM)	$ 10,000
TOTAL COST	$ 103,000

The total cost for clean-up of Well #23, conversion to a monitoring well, and construction and installation of a relief well is approximately $200,000 which includes a 10% contingency cost.

V Barrier Wells

A. CONSTRUCTION AND INSTALLATION

The number, location, design, and depth of barrier wells is to be determined with the aid of a hydrogeologic model being assembled by the USGS and by analytical work being conducted by Hickok & Associates and Geraghty & Miller. This work is scheduled for completion by October, 1981. Therefore, it was necessary to make the following assumptions:

1. Three groundwater barrier wells will be installed in each of the five aquifers.

2. The barrier wells' diameter will be eight (8) inches based on the premise that the diameter of the well casing should be at least two sizes larger than the nominal diameter of the pump.

3. A 4-inch submersible pump will be used for extraction volumes of less than 100 gpm and a 6-inch submersible pump for yield requirements of 150 to 400 gpm.

4. The depth of the well for each of the five aquifers is as follows:

a. Drift	65 feet
b. Platteville	100 feet
c. St. Peter	200 feet
d. Prarie du Chien-Jordan	500 feet
e. Hinckley	1000 feet

1. Drift

a. Drilling (auger) with sampling ($20/foot)	$ 1,300
b. Eight (8)-inch PVC casing ($10.50/foot)	$ 580
c. Four (4)-inch submersible pump	$ 4,910
d. Eight (8)-inch PVC screen ($21.00/foot)	$ 210
COST PER WELL	$ 7,000
THREE (3) WELLS	x 3
TOTAL COSTS	$ 21,000

2. Platteville

a. Drilling (auger) with sampling (80' @ $20/foot)	$ 1,600
b. Coring rock (20' @ $50/foot)	$ 1,000
c. Eight (8)-inch PVC casing (90' @ $10.50/foot)	$ 945
d. Four (4)-inch submersible pump	$ 4,910
COST PER WELL	$ 8,455
THREE (3) WELLS	x 3
TOTAL COSTS	$ 25,365

3. St. Peter

a. Drilling (auger) with sampling (80' @ $20/foot)	$ 1,600
b. Coring rock (120' @ $50/foot)	$ 6,000
c. Eight (8)-inch PVC casing (100' @ $10.50/foot)	$ 1,050
d. Four (4)-inch submersible pump (40 to 150 feet deep and producing 50 to 125 gpm)	$ 4,910
COST PER WELL	$ 13,560
THREE (3) WELLS	x 3
TOTAL COSTS	$ 40,680

4. Prarie du Chien-Jordan

a. Drilling (auger) with sampling (80' @ $20/foot)	$ 1,600
b. Coring rock (420' @ $75/foot)	$ 31,500
c. Eight (8)-inch PVC casing (300' @ $10.50/foot)	$ 3,150
d. Six (6)-inch submersible pump	$ 9,620
COST PER WELL	$ 45,870
THREE (3) WELLS	x 3
TOTAL COSTS	$ 137,610

5. Hinckley

a. Drilling (auger) with sampling (80' @ $20/foot)	$ 1,600
b. Coring rock (920' @ $100/foot)	$ 92,000
c. Eight (8)-inch PVC casing (900' @ $10.50/foot)	$ 9,450
d. Six (6)-inch submersible pump (200 to 500 feet deep and producing 15 to 135 gpm)	$ 9,620
COST PER WELL	$ 112,670
THREE (3) WELLS	x 3
TOTAL COSTS	$ 338,010

Total cost of the five aquifers	$ 562,665
Contingency (10%)	$ 56,270
TOTAL COST	$ 618,935

The use of St. Louis Park wells and the modification of multiaquifer wells into barrier wells were not considered. However, the incorporation of such wells into the barrier well system would significantly decrease the cost of this element.

B. MONITORING

1. Constructing and installation of groundwater monitoring wells

The number, location design and depth of groundwater monitoring wells will be determined based upon the USGS hydrogeologic model and analytical work by Hickok & Associates and Geraghty & Miller to indicate the effectiveness of the barrier well system.

Two options will be developed as part of this element of the cost estimate. The following assumptions have been made:

1. Casing and well screen material will be two (2)-inch I.D.

   a. Stainless Steel
   b. PVC

2. Three wells will monitor each barrier well.
3. Drilling (auger) with 3 1/4-inch hollow stem augers.
4. Drilling rock with NXM core barrel.
5. The depths of the wells for each of the five (5) aquifers is as follows:

a. Drift	65 feet
b. Platteville	100 feet
c. St. Peter	200 feet
d. Prarie du Chien-Jordan	500 feet
e. Hinckley	1000 feet

a. Drift	PVC	Stainless Steel
1. Construction and installation ($5/foot)	$ 975	$ 975
2. Five (5) foot well screen	$ 10	$ 150
3. Casing (60')	$ 120	$ 900
COST PER WELL	$ 1,105	$ 2,025
THREE (3) WELLS	x 3	x 3
TOTAL COSTS	$ 3,315	$ 6,075

b. Platteville	PVC	Stainless Steel
1. Construction & installation (80' @ $15/foot)	$ 1,200	$ 1,200
2. Coring (20' @ $25/foot)	$ 500	$ 500
3. Casing (95')	$ 190	$ 1,425
COST PER WELL	$ 1,890	$ 3,125
THREE (3) WELLS	x 3	x 3
TOTAL COSTS	$ 5,670	$ 9,375

c. St. Peter	PVC	Stainless Steel
1. Construction & installation (80' @ $15/foot)	$ 1,200	$ 1,200
2. Coring (120' @ $25/foot)	$ 3,000	$ 3,000
3. Casing (190')	$ 380	$ 2,850
COST PER WELL	$ 4,580	$ 7,050
THREE (3) WELLS	x 3	x 3
TOTAL COSTS	$ 13,740	$ 21,150

		PVC	Stainless Steel
d. Prarie du Chien-Jordan			
1. Construction & installation (80' @ $15/foot)		$ 1,200	$ 1,200
2. Coring (420' @ $50/foot)		$ 21,000	$ 21,000
3. Casing (490')		$ 980	$ 7,350
	COST PER WELL	$ 23,180	$ 29,550
	THREE (3) WELLS	x 3	x 3
	TOTAL COSTS	$ 69,540	$ 88,650
e. Hinckley			
1. Construction & installation (80' @ $15/foot)		$ 1,200	$ 1,200
2. Coring (920' @ $75/foot)		$ 69,000	$ 69,000
3. Casing (990')		$ 1,980	$ 14,850
	COST PER WELL	$ 72,180	$ 85,050
	THREE (3) WELLS	x 3	x 3
	TOTAL COSTS	$ 216,540	$ 255,150

2. Management of barrier well system

This element will be included as part of the well field management program (see Section VI).

C. BARRIER WELLS WASTE WATER TREATMENT FACILITIES

There are two (2) potential waste water sources which may be derived from the groundwater control wells. The contaminated shallow aquifers have been identified and characterized in the report by Barr Engineering, and the deep aquifers were briefly evaluated in the same report. Realizing the purpose of this evaluation is to develop a cost estimate for the redemial activities numerous of assumptions have been made in order to complete the estimate. The salient assumptions are outlined below,

for the shallow aquifer:

1. Flow - drift @ 100 gpm
   Platteville @ 100 gpm
   St. Peter @ 100 gpm
   Prarie du Chien-Jordan @ 225 gpm

2. Characteristics - the glacial drift is the maximium projected for the gradient control wells in the Barr report - all other flows are equal to the minimum projected for the glacial drift in the same report.

3. Treatment - the municipal treatment system cannot handle the potential toxic shock affect of a slug of PAH's;

- biological treatment is not applicable because of the probable waste load variability;
- physical/chemical treatment is the best technology available to handle the projected variability;
- activated carbon will be able to reduce the Polynuclear Aromatic Hydrocarbons (PAH's) to acceptable levels;
- for the first 10 years the effluent from the treatment plant will be discharged to the municipal treatment system to handle residuals.

for the deep aquifer:

1. Flow - 1500 gpm total, purpose is to control the speed of pollutants by balancing the affect of the municipal wells drawing from the area.

2. Characteristics - the raw untreated levels will meet NPDES standards to the Minnehaha Creek.

3. Treatment - the creek will be able to handle the additional flow;

   - equalization facilities are necessary to homogenize the waste and and make available an alternative for possible discharge diversion.

A brief description of a treatment train of facilities which theoritically should be able to handle the shallow aquifers projected waste streams is as follows:

> One day equalization facilities will homogenize the waste, eliminate most surges, and act as a buffer for equipment failure farther down the treatment train. After equalization chemical addition facilities will break the emulsified organics with oxidanes or coagulants. The chemicals will be added at one-half the oil and grease concentration and produce a suspended solids concentration of approximately 600 mg/l. During evaluation of chemical selection, every effort should be made to avoid those containing chlorine because of the high potential for the production of chlorinated hydrocarbons. The suspended solids and oil & grease will be removing by filtration (vacuum or pressure) at a rate of 4-lbs./sq.ft./hr. The discharge will pass through activated carbon columns which will absorb phenol substances at 0.05/lbs./lb. of carbon and hopefully remove the PAH's to acceptable levels.

This treatment train was based on information from the Barr Engineering report, treatability characteristics of coal tar waste, previous experiences with industrial treatment systems, and sound engineering judgement. Further studies are required before any decisions are made concerning a feasible treatment train. The studies themselves along with waste characteristization could run $300,000 to evaluate the treatment of the waste.

The conceptual capital cost estimate is summarized on Table 1 and totals approximately $5,000,000 while the operation on Table 2 totals approximately $46,000,000 for 35 years of operation. The costs were derived from different sources, but all costs were escalated to 1st quarter 1981 dollars using the Engineering News Record Construction Cost Index of 3400. This estimate does not allow for unusual site preparation, either physically or legally. Using these procedures, the total capital costs should not be understood as accurate to +50% to -40%, which is acceptable to the Cost Estimates Society considering the amount of data available.

TABLE 1

Summary of Conceptual Capital Cost Estimate for Treatment of Gradient Control Wells Waste Water

Treatment Facilities For Shallow Aquifers		1st. Quarter 1981
Equalization		$ 200,000
Chemical Addition		$ 50,000
Filtration		$ 1,000,000
Activated Carbon		$ 1,130,000
Effluent Handling		$ 50,000
Sludge Handling		$ 150,000
Treatment Facilities For Deep Aquifers		
Equalization		$ 350,000
Effluent Handling		$ 20,000
	Subtotal	$ 2,950,000
Auxiliary Costs		
Piping (10%)		$ 300,000
Electrical (8%)		$ 240,000
Instrumentation (5%)		$ 150,000
Site Preparation (5%)		$ 150,000
	Subtotal	$ 3,790,000
Engineering and Construction Supervision (15%)		$ 570,000
Contingencies (15%)		$ 570,000
	TOTAL COST	$ 4,930,000

TABLE 2

Summary of Conceptual Operation & Maintenances Cost Estimate For Treatment of Gradient Control Wells Waste Water

Item	Yearly Cost	35 Year Cost in 1981 Dollars
Power	$ 80,000	$ 2,800,000
Labor	$ 320,000	$ 11,200,000
Material	$ 100,000	$ 3,500,000
Chemicals	$ 400,000	$ 14,000,000
User Charge & Industrial Cost Recovery*	$ 1,200,000	$ 12,000,000
Sludge Disposal	$ 20,000	$ 700,000
Taxes & Insurance	$ 50,000	$ 1,750,000
TOTAL 35 YEAR O & M		$ 45,950,000

* The effluent will only be discharged for the first 10 years to the City treatment plant, the remaining years it will be discharged directly to the Minnehaha Creek.

VI Well Field Management

Groundwater monitoring wells must be sampled periodically to evaluate the effectiveness of the barrier well system, the modifications of the multiaquifer wells, and clean-up of "point" sources of contamination (soil and Well #23). Samples taken from groundwater monitoring wells and other area wells need to be analyzed for chemical parameters associated with the subject site as part of the aforementioned evaluation.

In order to accomplish the goals of a sound well field management program, it was assumed that monitoring would be necessary for fifty (50) years. It is anticipated that approximately fifteen (15) barrier wells will be necessary to control the further spread of contaminants as well as clean up the groundwater system. There will be approximately forty-five (45) groundwater monitoring wells to monitor the effectiveness of the barrier wells. Well #23 will be monitored individually because of the uniqueness of the problems associated with it. Additionally, approximately 139 area wells will be monitored to ensure that the contamination is not spreading beyond the "controlled" area.

All sixty (60) barrier and monitoring wells will be sampled four (4) times during the initial year of the program to obtain reliable base data. As the well management program is implemented, it is anticipated that monitoring requirements will decrease. Therefore, after the initial year of sampling, the following monitoring program was assumed:

1. There will be two (2) samplings per year for four (4) years, and

2. One (1) sampling per year for the following forty-five (45) years.

The approximately one hundred thirty-nine (139) area wells will be sampled two (2) times each year for the initial five (5) years and one (1) time each of the subsequent forty-five (45) years.

In order to collect reliable data on the type and amount of contamination, the first two (2) samplings will be analyzed by gas chromatography/mass spectroscopy (GC/MS) to identify organic compounds present in the groundwater wells. This will include all of the approximately two hundred (200) wells in the program. Assuming that the initial two (2) samplings are sufficient for a reliable base, the remaining sample analysis may be accomplished by other methods such as analysis of only one (1) significant fraction of the sample. Other methods may lead to significant cost reductions. Therefore, costs for two (2) scenarios are included in this cost estimate.

Costs for sampling and data analysis were derived by adapting the following assumptions:

1. Sampling will take two (2) people two (2) hours per well at a cost of fity (50) dollars per hour for the sampling team.

2. Data interpretation will take one (1) person one (1) hour per well at a cost of forty (40) dollars per hour.

3. The N.P.D.E.S. permit and local sewer authority will require monthly sampling and analysis for the two (2) involved discharges.

Schedule 1
Costs for monitoring Well #23 (all lab analysis by GC/MS):

Sampling	$ 2,000	
Lab Analysis	$ 55,000	
Data Analysis	$ 1,800	
Subtotal	$ 58,800	
		$ 58,800

Costs for monitoring barrier wells (all lab analysis by GC/MS):

Sampling	$ 171,000	
Lab Analysis	$ 855,000	
Data Analysis	$ 34,200	
Subtotal	$ 1,060,200	
		$ 1,119,000

Costs for monitoring wells (all lab analysis by GC/MS):

Sampling	$ 513,000	
Lab Analysis	$ 2,565,000	
Data Analysis	$ 102,600	
Subtotal	$ 3,180,600	
		$ 4,299,600

Costs for monitoring area wells (all lab analysis by GC/MS):

Sampling	$ 1,529,000	
Lab Analysis	$ 7,645,000	
Data Analysis	$ 305,800	
Subtotal	$ 9,479,800	
		$ 13,779,400

Costs for NPDES/Sewer District Compliance Monitoring (all lab analysis by GC/MS):

Sampling	$ 120,000	
Lab Analysis	$ 1,200,000	
Subtotal	$ 1,320,000	
Subtotals		$ 15,099,400
10% Contingence		$ 1,510,000
Total		$ 16,609,400

Schedule 2

Costs for monitoring Well #23 (lab analysis by GC/MS and GC):

Sampling	$ 2,000	
Lab Analysis	$ 15,000	
Data Analysis	$ 1,800	
Subtotal	$ 18,000	
		$ 18,000

Costs for monitoring barrier wells (lab analysis by GC/MS and GC):

Sampling	$ 171,000	
Lab Analysis	$ 168,000	
Data Analysis	$ 34,200	
Subtotal	$ 373,000	
		$ 392,000

Costs for monitoring wells (lab analysis by GC/MS and GC):

Sampling	$ 513,000	
Lab Analysis	$ 504,000	
Data Analysis	$ 102,600	
Subtotal	$ 1,119,600	
		$ 1,511,600

Costs for monitoring area wells (lab analysis by GC/MS and GC):

Sampling	$ 1,529,000	
Lab Analysis	$ 1,751,400	
Data Analysis	$ 305,800	
	$ 3,586,200	
		$ 5,097,800

Costs for NPDES/Sewer District Compliance Monitoring (lab analysis by GC/MS and GC):

Sampling	$ 120,000	
Lab Analysis	$ 1,200,000	
Subtotal	$ 1,320,000	
Subtotals		$ 6,417,800
10% contingency		$ 641,800
Total		$ 7,059,600

Summary

The final estimated cost of clean-up of soil and groundwater at the Reilly Tar and Chemical Company as delineated in this cost analysis ranges from approximately $167 million for low options to approximately $272 million for high options. Included in these figures, which are summarized below, is a 10% contingency cost as a safety margin to protect against hidden costs or underpriced elements of the analysis. The low and high options are based on alternatives presented in the various elements of the estimate.

Difficulties encountered in making an accurate cost estimate stem from: 1) the large number of unknown factors involved (quantities, effectiveness of systems, etc.); 2) the accurate depiction of waste types involved; 3) the large number of assumptions needed to construct the scenario; 4) "other variables". The aforementioned unknowns necessitate the use of worst case assumptions for cost estimation. Therefore, the variance of actual costs from the final estimated costs may be substantial. However, any deviations should be to the low side due to worst case assumptions.

	Low	High
1. Treatment of St. Louis Park Well Water	$ 3,870,000	$ 10,188,000
2. Multiaquifer Wells	$ 49,100	$ 109,400
3. Contaminated Soils	$104,000,000	$193,000,000
4. Well #23 Clean-Up	$ 200,000	$ 200,000
5. Barrier Wells	$ 51,716,000	$ 51,754,000
6. Well Field Management	$ 7,059,600	$ 16,609,400
FINAL COSTS	$166,894,700	$271,860,800

ca

003259